

**REMARKS**

Claims 1-18 are pending in this application. By this Amendment, claims 1, 2, 4 and 5 are amended to address the teachings of the references cited in the Office Action.

Support for the amendments to claims 1, 2, 4 and 5 can be found throughout the specification at, for example, page 7, lines 21-26, page 12, lines 6-9, page 17, lines 17-24, page 18, lines 15-22 and page 19, lines 18-26. No new matter is added to the application by this Amendment.

Applicants appreciate the courtesies shown to Applicants' representative by Examiner Song in the May 24, 2007 personal interview. Applicants' separate record of the substance of the interview is incorporated into the following remarks.

Entry of the amendments is proper under 37 CFR §1.116 since the amendments: (a) place the application in condition for allowance for the reasons discussed herein; (b) do not raise any new issue requiring further search and/or consideration as the amendments amplify issues previously discussed throughout prosecution; and (c) place the application in better form for appeal, should an appeal be necessary. The amendments are necessary and were not earlier presented because the amendments are made in response to arguments raised in the final rejection. Entry of the amendments is thus respectfully requested.

Reconsideration of the application is respectfully requested.

**I. Rejection under 35 U.S.C. §102(b)**

**A. Shibata et al.**

Claims 7-11 and 14-17 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by EP 1184488 A2 to Shibata et al. Applicants respectfully disagree.

The Patent Office alleges that Shibata et al. discloses all limitations recited in claims 7-11 and 14-17.

Applicants submit that Shibata et al. fails to disclose an apparatus for producing an Al-containing III-V group compound semiconductor by growing its crystal by hydride vapor phase epitaxy in a reactor having a single wall reaction chamber made only of quartz as recited in claim 7.

Claims 7-11 and 14-17 are directed to subject matter that prevents the reactor body from being corroded by AlCl gas by limiting the temperature range in the first step or first reaction zone to a temperature of 700°C or less.

Applicants submit that the embodiments of a reactor disclosed in Figs. 1-4 of Shibata et al. are not the same as or similar to a reactor having a single wall reaction chamber made only of quartz as recited in claim 7.

Fig. 1 of Shibata et al. discloses that the whole reactor body is made of an aluminum nitride material that is not corrodible by an AlCl gas and which has a hexagonal or a cubic crystal structure.

In Fig. 2 of Shibata et al., the reactor body 11a is made of a silicon oxide-based material such as quartz coated with an aluminum nitride film 11b coated on the inner surface of the reactor body. The reactor body 11a in Fig. 2 is not reactive with AlCl gas because the aluminum nitride film is non-reactive to AlCl gas.

In Fig. 3 of Shibata et al., the reactor 11 has a first reactor part 11-1 made of a quartz material, a second reactor part 11-2 made of aluminum nitride material and a third reactor part 11-3 made of a quartz material. Shibata et al. teaches that the second reactor part is exposed to AlCl gas and is not reactive with AlCl gas because of the aluminum nitride material thereon. The first reactor part and the third reactor part are not exposed to AlCl gas but are made of silicon oxide-based material which is reactive with AlCl gas. Thus, the reactor body of Fig. 3 of Shibata et al. prevents AlCl gas from corroding the reactor body (first and third reactor parts) by merely not exposing the reactor part free of aluminum nitride

material to AlCl gas. The reactor of Fig. 3 of Shibata et al. is not the same as or similar to the a reactor having a single wall reaction chamber made only of quartz as recited in claim 7 because the second reactor part of the reactor of Fig. 3 has aluminum nitride material thereon.

In Fig. 4 of Shibata et al., the apparatus has a double structure reactor constructed of an inner quartz reactor and an outer quartz reactor. This double structure reactor is corrodible by AlCl gas because the reactor is made of quartz which requires the inner quartz reactor to be exchanged periodically after corrosion from AlCl gas has damaged the inner quartz reactor. Shibata et al. teaches that a gas concentration sensor is positioned adjacent to the outer quartz reactor to measure a degree of corrosion for the inner quartz reactor to determine when the inner quartz reactor should be exchanged with a new inner quartz reactor. Thus, the double structure reactor in Fig. 4 discloses an inner quartz reactor that is corroded by AlCl gas and requires periodic replacement.

The concentration sensor in Fig. 4 of Shibata is provided between the inner reactor and the outer reactor, is set to measure the degree of corrosion, and provides information as to when the inner reactor should be replaced with a new inner reactor. Clearly, the purpose of the gas concentration sensor is to detect a gas leak between the inner reactor and the outer reactor when the inner reactor is corroded by AlCl. Further, Shibata et al. teaches that a small degree of gas leak is allowable in fabricating a III-V nitride film and that the inner reactor is replaced when the gas leak concentration exceeds a threshold value. Thus, the Shibata et al. teaches that the double structure reactor is used to prevent gas leaks from the double structure reactor when the inner reactor is corroded by AlCl gas, and that the double structure reactor is not capable of preventing corrosion from AlCl gas.

Contrary to the teachings of Shibata et al., the recited apparatus of claim 7 is capable of preventing the reactor body having a single wall reaction chamber made only of quartz from being corroded by AlCl gas. By providing a first reaction zone maintained at a

temperature of 700°C or below, the reactor body of the present claims prevents corrosion from AlCl gas. The double structure reactor of Fig. 4 in Shibata et al. cannot prevent corrosion of the inner reactor, requires replacement of the corroded inner reactor when the gas concentration sensor determines the gas concentration has exceed a threshold value, and uses the gas concentration sensor to determine when gas concentration between the inner and outer reactors may result in damage to the outer reactor. Thus, Shibata et al. requires the double structure reactor to prevent AlCl gas leaks from double structure reactor when the inner reactor is corroded by AlCl gas.

Therefore, none of the embodiments of Shibata et al. is a single wall reactor composed solely of quartz as required in claim 7.

In view of the foregoing, Shibata et al. fails to disclose each and every limitation of independent claim 7 and thus cannot anticipate claim 7, or any of the additional features recited in the dependent claims thereof. Accordingly, reconsideration and withdrawal of this rejection are respectfully requested.

**B. Hong et al.**

Claims 7-11 and 14-17 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by U.S. Patent No. 6,177,292 to Hong et al. Applicants respectfully disagree.

The Patent Office alleges that Hong et al. discloses all of the features recited in claims 7-11 and 14-17.

Applicants submit that Hong et al. fails to disclose an apparatus for producing an Al-containing III-V group compound semiconductor by growing its crystal by hydride vapor phase epitaxy in a reactor having a single wall reaction chamber made only of quartz as recited in amended claim 7. Moreover, growth of a GaN substrate as taught by Hong et al. is not the same as or similar to producing an Al-containing III-V group compound semiconductor as recited in claim 1.

Hong et al. discloses a method for producing a single crystal GaN substrate which allows fast homoepitaxial growth of GaN group materials, formation of a bulk single crystal GaN substrate (see col. 1, lines 8-13 of Hong et al.). Nowhere does Hong et al. teach or suggest a method or apparatus for producing an Al-containing III-V group compound semiconductor.

In view of the foregoing, Hong et al. fails to disclose each and every limitation of independent claim 7 and thus cannot anticipate claim 7, or any of the additional features recited in the dependent claims thereof. Accordingly, reconsideration and withdrawal of this rejection are respectfully requested.

## **II. Rejections Under 35 U.S.C. §103(a)**

### **A. Nikolaev et al.**

Claims 1, 3 and 18 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 6,218,269 to Nikolaev et al. This rejection is respectfully traversed.

Nikolaev et al. fails to teach or suggest a method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy in a reaction chamber made only of quartz material as recited in claim 1. Moreover, Nikolaev et al. fails to teach or suggest a first step of reacting a solid Al with a halogenated hydrogen at a temperature of 700°C or below to produce a halogenated product of Al, wherein the first step occurs in a first reaction zone of the reaction chamber as recited in claim 1.

FIGS. 1 and 2 of the present application illustrate the criticality of reacting a solid Al with a halogenated hydrogen at a temperature of 700°C or below to produce a halogenated product of Al. Specifically, FIG. 1 illustrates that generation of AlCl, which reacts with the quartz reaction tube, is suppressed and the generation of AlCl<sub>3</sub>, which does not react with the

quartz reaction tube, becomes predominant at 700°C or below (see FIG. 1 and page 12, lines 6-9 of the present specification). FIG. 2 illustrates that gaseous halogenated products of Al and Ga obtained at 700°C or below do not react with the quartz reaction tube (see FIG. 2 and page 12, lines 23-25 of the present application).

FIGS. 4 and 5 of the present application illustrate comparative example and example, respectively, in which HCl and hydrogen were introduced into the Al material area (first reaction zone of the reaction chamber) with the temperature of the crystallization area (second reaction zone of the reaction chamber) set to 1000°C.

In the comparative example disclosed in FIG. 4, the temperature of the Al material area (first reaction zone of the reaction chamber) was set to 850°C and AlCl gas was transported from the material area into the crystallization area (second reaction zone of the reaction chamber). As a result, the inside of the quartz reaction tube turned yellow from the oxide of Al at the middle section of the quartz reaction tube (see page 20, lines 11-24 of the present application).

In the example disclosed in FIG. 5, the temperature of the Al material area was set to 650°C and substantially no AlCl gas was generated. Because the Al component was transported in the form of AlCl<sub>3</sub>, the quartz reaction tube exhibited no color change (see page 20, line 26 to page 21, line 15 of the present application).

Thus, the information disclosed in FIGS. 1, 2, 4 and 5 of the present specification demonstrates that generation of AlCl, which reacts with the quartz reaction tube, is suppressed and the generation of AlCl<sub>3</sub>, which does not react with the quartz reaction tube, becomes predominant at 700°C or below.

Attached is a Declaration under 37 CFR §1.132 (Declaration) illustrating the criticality of reacting a solid Al with a halogenated hydrogen at a temperature of 700°C or below in a first reaction zone of the reaction chamber, made solely of quartz, during the first

step of the reaction as required in claim 1. By reacting a solid Al with a halogenated hydrogen at a temperature of 700°C or below in the first reaction zone, the Al component is transported into the second reaction zone in the form of  $\text{AlCl}_3$  and prevents the quartz reaction tube of the second reaction zone from being corroded, damaged or discolored by the Al component therein. Graphs 1 and 2 of the Declaration illustrate SIMS depth profiles of an AlN layer for the comparative example and the example disclosed in FIGS. 4 and 5, respectively, of the present application. As discussed above, the temperature of the Al material area (first reaction zone of the reaction chamber) of the example disclosed in FIG. 4 was set to 850°C and the temperature of the Al material area (first reaction zone of the reaction chamber) of the example disclosed in FIG. 5 was set to 650°C.

As shown in Graphs 1 and 2 of the Declaration, the intensity of [Si] for the comparative example disclosed in FIG. 4 as shown in Graph 1 is over 100 times as high as that of the intensity of [Si] for the example disclosed in FIG. 5 of the present application (temperature of Al material area set to 650°C). The high intensity of [Si] for the example disclosed in FIG. 5 is caused by deoxidizing and corroding of the quartz reaction tube by the Al component,  $\text{AlCl}$  gas, present at the second reaction zone. As a result of reacting the solid Al with a halogenated hydrogen at a temperature of 850°C (comparative example of FIG. 4 of the present application) in a first reaction zone, the quartz reaction tube at the second reaction zone is deoxidized and corroded by the Al component,  $\text{AlCl}$  gas, and [Si] is emitted.

Graphs 3 and 4 of the Declaration illustrate an absorption spectra of AlN layer at the second reaction zone when the Al material area (first reaction zone) is set to 600°C and 850°C, respectively. The absorption spectra in Graph 3 has a sharper rising shape than that of the absorption spectra in Graph 4. In the data of Graph 4 (first reaction zone at 850°C), there are absorption spectra at the range of photon energy under the edge of the band (=5.818eV), while the absorption spectra in Graph 3 (first reaction zone at 600°C) is at a the range of

photon energy under the edge of the band ( $\approx 6.109\text{eV}$ ). Thus, the crystallinity of AlN of Graph 3 (at  $600^\circ\text{C}$ ) is higher than that of Graph 4 (at  $850^\circ\text{C}$ ). The crystallinity of AlN at  $600^\circ\text{C}$  is higher than the crystallinity of AlN at  $850^\circ\text{C}$  because the quartz reaction tube is not corroded at the temperature range of  $700^\circ\text{C}$  or below, such as  $600^\circ\text{C}$ .

Thus, the results illustrated in Graphs 1-4 of the Declaration demonstrate that reacting a solid Al with a halogenated hydrogen at a temperature of  $700^\circ\text{C}$  or below in a first reaction zone of the reaction chamber is critical to producing an Al component,  $\text{AlCl}_3$  for transporting into the second reaction zone that prevents the quartz reaction tube of the second reaction zone from being corroded, damaged or discolored by the Al component therein.

Because these unexpected results are not taught or suggested by Nikolaev et al., Nikolaev et al. would not have rendered the features of claims 1 and 3 obvious to one of ordinary skill in the art.

For at least these reasons, claims 1, 3 and 18, are patentable over the applied reference. Thus, withdrawal of the rejection under 35 U.S.C. §103(a) is respectfully requested.

**B. Nikolaev et al. in view of Shibata et al. and Vaudo et al.**

Claims 4 and 6 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Nikolaev et al. in view of Shibata et al. and U.S. Patent No. 6,533,874 to Vaudo et al. The rejection is respectfully traversed.

As discussed with respect to claim 1, Nikolaev et al. fails to teach the recited a first step of reacting a solid Al with a halogenated hydrogen at a temperature of  $700^\circ\text{C}$  or below to produce an halogenated product of Al, wherein the first step occurs in a first reaction zone of the reaction chamber which is made only of quartz.



Neither Shibata et al. nor Vaudo et al. remedy the deficiencies of Nikolaev et al. Thus, none of Nikolaev et al., Shibata et al. and Vaudo et al., taken singly or in combination, teach or suggest the recited method of claim 4.

Because these features of independent claim 4 are not taught or suggested by Nikolaev et al., Shibata et al. and Vaudo et al., taken singly or in combination, these applied references would not have rendered the features of claims 4 and 6 obvious to one of ordinary skill in the art.

For at least these reasons, claims 4 and 6 are patentable over all the applied references. Thus, withdrawal of the rejection under 35 U.S.C. §103(a) is respectfully requested.

**C. Nikolaev et al. in view of Solomon et al.**

Claims 2 and 12 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Nikolaev et al. in view of International Patent Application Publication No. WO 00/68470 A1 to Solomon et al. The rejection is respectfully traversed.

As discussed with respect to claims 1 and 4, Nikolaev et al. fails to teach the recited a first step of reacting a solid Al with a halogenated hydrogen at a temperature of 700°C or below to produce an halogenated product of Al, wherein the first step occurs in a first reaction zone of the reaction chamber which is made only of quartz.

Solomon et al. does not remedy the deficiencies of Nikolaev et al. Thus, Nikolaev et al. and Solomon et al., taken singly or in combination, teach or suggest the recited method of claim 2.

Because this feature of independent claim 2 is not taught nor suggested by Nikolaev et al. and Solomon et al., taken singly or in combination, Nikolaev et al. and Solomon et al. would not have rendered the features of claims 2 and 12 obvious to one of ordinary skill in the art.

For at least these reasons, independent claims 2 and 12 are patentable over all the applied reference. Thus, withdrawal of the rejection under 35 U.S.C. §103(a) is respectfully requested.

**D. Nikolaev et al. in view of Solomon et al., Shibata et al. and Vaudo et al.**

Claims 5 and 13 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Nikolaev et al. and Solomon et al. in view of Shibata et al. and Vaudo et al. The rejection is respectfully traversed.

As discussed with respect to claims 1, 2 and 4, Nikolaev et al. fails to teach the recited a first step of reacting a solid Al with a halogenated hydrogen at a temperature of 700°C or below to produce an halogenated product of Al, wherein the first step occurs in a first reaction zone of the reaction chamber which is made only of quartz.

None of Solomon et al., Shibata et al. and Vaudo et al. remedy the deficiencies of Nikolaev et al. Thus, Nikolaev et al., Solomon et al., Shibata et al. and Vaudo et al., taken singly or in combination, teach or suggest the recited method of claim 5.

Because this feature of independent claim 5 is not taught nor suggested by Nikolaev et al., Solomon et al., Shibata et al. and Vaudo et al., taken singly or in combination, the cited references would not have rendered the features of claims 5 and 13 obvious to one of ordinary skill in the art.

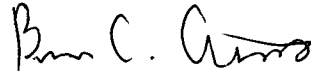
For at least these reasons, claims 5 and 13 are patentable over all the applied reference. Thus, withdrawal of the rejection under 35 U.S.C. §103(a) is respectfully requested.

**III. Conclusion**

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-18 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



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JAO:BCA/hs

Attachment:

Declaration under 37 C.F.R. §1.132

Date: August 16, 2007

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